Velocity Devices Inc.

The fire in your ATV

USB Memory Interface
Operating Instructions

Rev. 1.1
Release Date: 2006/01/10

***Shown with optional cable**

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The fire in your ATV

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1 INSTALLATION

Get the latest version at: http://www.velocitydevices.com. Click on the "support" tab to take you to the download page.

Click on the "COPPERHEAD.EXE" application to start the installation process. Follow the prompts to install the application on your computer. Connect the USB Memory interface to the computer using a USB male-A to USB male-A cable. The computer will detect the interface, and start the driver installation. Windows XP will automatically install the required drivers. Windows 98 will require the driver to be installed. Follow the onscreen prompts, and point the installation to the directory where the Copperhead application was installed (defaults to C:\Program Files\Copperhead) for the proper driver. You may require your original windows installation CD for the installation. Insert it into the CDROM drive if prompted.

Reboot your computer, and the installation will be complete.

NOTE:
THE USB MEMORY INTERFACE MUST BE LOADED WITH A MAP BEFORE CONNECTING IT TO THE COPPERHEAD. DO NOT CONNECT THE USB MEMORY INTERFACE TO THE CDI UNTIL THE USB MEMORY INTERFACE HAS BEEN PROGRAMMED.

2 TIMING ADVANCE PRIMER:

The gasoline combustion engine requires three elements in order to produce horsepower:

1) Air
2) Fuel
3) Source of ignition (i.e. spark plug)

Key Terms and Acronyms:

Stoichiometric Ratio	14.7 parts air to 1 part fuel, where during combustion 100% of the fuel is burned (theoretical combustion)
A/F	Air / Fuel mixture
TDC	Top Dead Center
BTDC	Before Top Dead Center
ATDC	After Top Dead Center
WOT	Wide Open Throttle
Pre-ignition (pinging)	A/F mixture ignites slightly early, and combustion tries to push the piston backwards just as it reaches TDC.
Detonation	Advanced stage of pre-ignition where combustion finishes before the piston reaches TDC. The combination of the combustion and the compression stroke can cause piston damage in extreme cases.

For proper ignition the ratio of air to fuel must be controlled. Ideally, 14.7 parts of air are mixed with 1 part of fuel (14.7:1, or stoichiometric ratio). This gives a 100% burnt mixture. For maximum power, the ratio is typically dropped to 12.5:1. This gives a richer mixture that generates more power, and is less prone to detonation. The leaner the mixture, the better the fuel economy. If the mixture becomes too lean, then you get "lean surge", and it extreme cases, misfiring.

In the ideal world, the spark plug would be fired when the piston reached TDC on the compression stroke. The combustion would force the piston down, and power would be generated.

Unfortunately, in the real world, there is a finite amount of time required for the A/F mixture to light and for combustion to be complete. For maximum power, maximum cylinder pressure from the combustion occurs ATDC. If it happens too soon, detonation occurs. If it happens too late, the combustion doesn't fully translate into power, and is lost as heat.

The crucial point is that for each RPM, we must fire at a specified time BTDC to ensure that maximum cylinder pressure occurs at the optimum time ATDC. The time before TDC is the critical component, and gets translated to timing advance, as we can measure angular markings on the crankshaft.

Several factors affect the need for timing advance.

1) Compression Ratio: Ratio of cylinder volume at BDC to the cylinder volume at TDC. Compression ratio is measured at WOT. During part throttle driving, the cylinders are only partially full of A/F. The effective compression ratio is lower, and more timing advance is required, since lower A/F mixtures burn slower. (Increase advance for low compression)
2) Octane level: Higher octane fuel burns slower and is less prone to detonation. (Increase advance for higher octane)
3) Air/Fuel Ratio: Leaner mixtures burn slower since the ratio is not optimum. (Increase advance for lower A/F ratio)

4) Temperature: Cooler engines are less prone to detonation. (Increase advance for lower temperature)

NOTE:
Constant Velocity (CV) carburetors utilize vacuum operated slides in the throttle body to regulate the airflow. The airflow rate through the carburetor remains constant, regardless of RPM. This allows for more consistent metering of fuel. The Kawasaki V-Twin engines have throttle slide springs that are calibrated to allow the slides to fully open at approximately 5000 RPM. Fully depressing the throttle at any RPM above 5000 RPM is considered WOT, since the slides are fully open. Even though the throttle is fully depressed at RPMs less than 5000 RPM, the engine isn't truly WOT, and the compression ratio is less than specified.

Below 5000 RPM, the time we need to fire BTDC is roughly constant. The stock CDI starts at 5 degrees BTDC at 1100 RPM and ends at 28 degrees BTDC at 5000 RPM (the full compression ratio point). As the engine speed increases, we need to increase the advance angle to ensure that we keep firing at that same time BTDC.

After 5000 RPM, we are running full compression ratio, so we need less timing advance. In the stock case, after 5000 RPM, the timing advance is held at 28 degrees. Even though the advance does not change, we start firing less and less BTDC as the RPM increases. Reason being is full compression ratio burns faster, and doesn't require as much advance.

Maximum power out of an engine occurs when the timing advance is set so that for every RPM, the timing advance is picked so that it is approximately 4 degrees before the detonation point of the engine.

Running less than optimum advance will make the engine run hotter, and will decrease the power output. Running more than required advance will lead to pre-ignition, which makes the engine run hotter, and decreases the power output of the engine at a larger rate than lower advance. For example, if a particular engine generates 100 HP at optimum advance. Running 2 degrees below optimum may give you only 95 HP. Running 2 degrees above optimum may give you 85 HP. Reason being is pre-ignition occurs, and it forces the engine backwards acting like a brake.

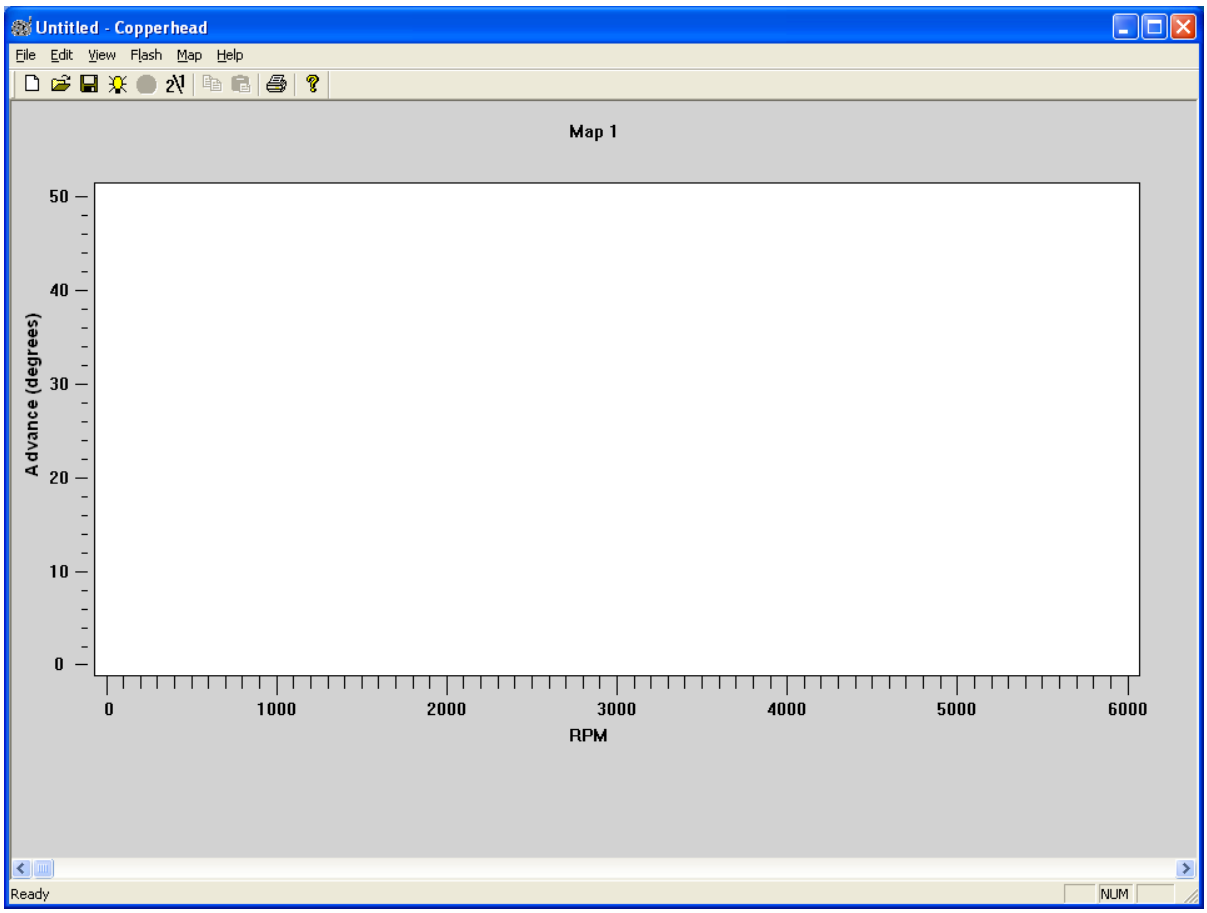
For optimum operation of an engine, the proper timing advance curve must be applied. Too much timing advance can be catastrophic to the pistons and bearings. Timing advance is typically set at less than optimum, because increases in outside temperature, engine load, etc. will cause the engine to heat up, and makes the engine more prone to detonation. Also, the cooling system is less optimum at lower speeds, which also causes a temperature increase of the engine.

3 QUICK TIPS

1) Use the MAP/LOAD DEFAULT to open the default map.
2) Use the +/- keys to zoom in and out respectively.
3) Use the "map" icon to write the maps and configurations displayed on the screen to the pod. NOTE: Both maps are downloaded at the same time.
4) Use the "yellow flashbulb" to download new firmware into the CDI. Browse for the .VDI file, and click "OPEN" to start the upgrade.

4 SCREEN OVERVIEW

The application starts with no timing maps loaded. The vertical axis of the map is the timing advance in degrees, and the horizontal axis is the RPM in 50-RPM increments. The first 6000 RPM is shown. Use the slider on the bottom of the screen to scroll left and right through all RPM points.



The header indicates the name of the maps you are editing. It will remain "Untitled" until you have saved the map under a different name. The task menu gives access to all the functions, and the toolbar (if enabled) will give quick access to many of the task menu functions.

4.1 Task Menu

4.1.1 FILE

The FILE menu gives access to opening, saving and printing maps.

4.1.2 EDIT

When a point is selected on the timing map, use these menu items to move the point up (more advance), down (less advance), prev (point 50-RPM below) or next (point 50-RPM above).

4.1.3 VIEW

The view menu allows you to turn on/off the toolbars as well as change the displayed map, zoom the maps or turn on/off the map gridlines. Use the "Zoom" menu to zoom in/out the timing map to see more resolution, or to see the whole map. Alternatively, the +/- buttons can be pressed to zoom in and out respectively. Use the "Map" button to change the current map being displayed. Alternatively, the 2/1 button can be pressed on the toolbar (if enabled).

4.1.4 FLASH

The flash button allows you to upgrade the CDI firmware when updates are available. Pressing the yellow flashbulb on the toolbar does the same function. Browse for the new firmware file, and press "open" to start the download. See the "Upgrading your CDI Firmware" section for more details on how to use this feature.

4.1.5 MAP

4.1.5.1 Load Default

Loads the default maps and configurations that the CDI was initially delivered with. NOTE: This just opens the maps. You still need to click "Write to Pod" or click the "map" icon to physically download the maps.

4.1.5.2 COPY MAP / PASTE MAP

Select the map you wish to copy by clicking on the 2/1 button on the toolbar, or by going to VIEW/MAP. Clicking on the "Copy Map" button will place the map onto the clipboard. Change to the other map, and click on "Paste Map" to overwrite the current map with the one on the clipboard.

4.1.5.3 Set Options

The options menu brings up a dialog box that allows you to change the revolution limiter for both timing maps (red line), as well as set the RPM that the four auxiliary wires will supply ground. The colored lines are displayed on the screen, and they correspond to the same color of wire in the Copperhead wiring harness. They are defaulted to 12000 RPM initially.

The colored lines can be used to trigger a shift light or NOS solenoid, for example. Use the spinner arrows to scroll the values up or down, or click on the number and type in a value. They are entered in 50-RPM increments.

The "Set Limiter" menu brings up a dialog box that allows you to turn on/off the safety limiters inside the CDI, for both timing maps. A check mark in the box means the limiter will be turned on. The factory CDI comes with all three of the limiters for Map #1 enabled. ***NOTE: SEVERE INJURY OR DEATH MAY RESULT FROM INEXPERIENCED RIDERS USING THE MACHINE WITH THE LIMITERS DISABLED.***

4.1.5.3.1 Limp Mode Enabled

If enabled, and the belt switch trips, the engine revolution limiter as set to 3600 RPM, and will remain so until the belt switch has been turned back on. This prevents catastrophic damage to the belt and the belt case should the belt become loose.

4.1.5.3.2 Reverse Limiter Enabled

If enabled, the engine revolution limiter as set to 3600 RPM when the machine is in reverse. You need to depress the "Reverse Override" button to get full power in reverse. If disabled, then you will always get full power in reverse.

4.1.5.3.3 Low Speed Retard Enabled

If enabled, the CDI will limit the timing advance to 12-degrees maximum until the wheel speed has exceeded 5 KPH/ 3 MPH. This prevents unpredictable wheelies from inexperienced riders. This feature is also useful for racing, as it allows better traction off the line when enabled.

Click "OK" to accept the changes, or click "CANCEL" to abandon them.

4.1.5.4 Write to Pod

The write to pod item will download the maps displayed on the screen to the USB Memory Interface. ***NOTE: Both maps and configurations are downloaded at the same time.***

4.1.5.5 ADD OFFSET

The "Add Offset" menu allows you to add/subtract timing advance from every point on the timing curve. Use the spinner to change the offset in 0.2-degree increments. Click "OK" to accept the changes, or click "CANCEL" to abandon them.

This is useful to adjust a map for different fuel grades, or to compensate for an offset key that has been installed in your machine.

Example 1:

Map #2 defaults to a profile and maximum advance (34-degrees) that is optimum for 87-octane fuel. Adding a 3.0-degree offset will change it to a curve (37-degrees) that is optimum for 91+-octane fuel.

Example 2:
Your machine has had an aftermarket 6-degree offset key installed. Since Map #2 defaults to 34-degrees, the effective advance will be 6-degrees + 34-degrees = 40-degrees. This is too much advance for the engine. By adding a –6.0-degree offset to Map #2, it will drop it down to 28-degrees. Now, your machine has 6-degrees + 28-degrees = 34-degrees. This is optimum for 87-octane fuel. Alternatively, you could have added a –3.0-degree offset to make it optimum for 91+-octane fuel.

4.1.6 HELP

The "Help" menu gives the current application revision number.

5 MODIFYING MAPS

Load a saved map using the FILE/OPEN command, or click on MAP/LOAD DEFAULT to load the default maps.

The screen will show the timing advance for every 50-RPM increment. Clicking on any point will make the application show the RPM and timing advance for that particular point in the top-left corner of the map window. The point can be adjusted by dragging the point up and down. Alternatively, use the EDIT/UP or EDIT/DOWN menu. Use the EDIT/PREV or EDIT/NEXT menu to move to the next point before or after the current point.

NOTE:
The CDI fixes the timing internally until 1500 RPM, regardless of what the map is configured to. This prevents off idle stumbles and stalls. The CDI starts reading the timing maps at 2000 RPM, and does linear interpolation between 1500 and 2000 RPM to ensure a smooth transition.

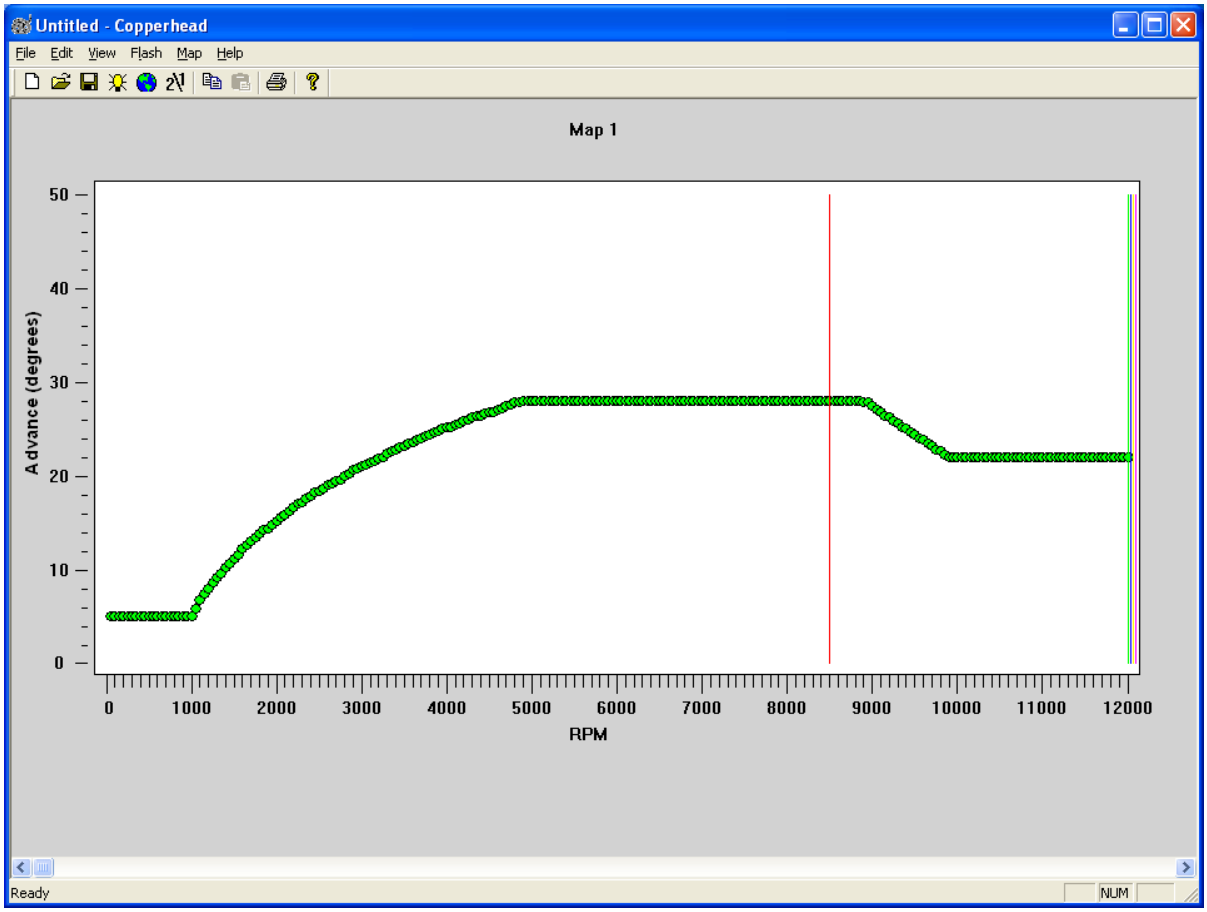
NOTE:
To prevent detonation, there cannot be any large steps between timing points. The curve must have a smooth flow to ensure trouble free operation. NON-UNIFORM MAPS, AND/OR EXCESSIVE TIMING ADVANCE CAN DESTROY YOUR ENGINE. CONSULT AN AUTHORIZED ENGINE BUILDER FOR ADVICE IF NECESSARY. VELOCITY DEVICES INC. IS NOT LIABLE FOR ANY DAMAGES OCCURRED BY IMPROPER USE OF THIS APPLICATION.

6 PROGRAMMING EXAMPLE

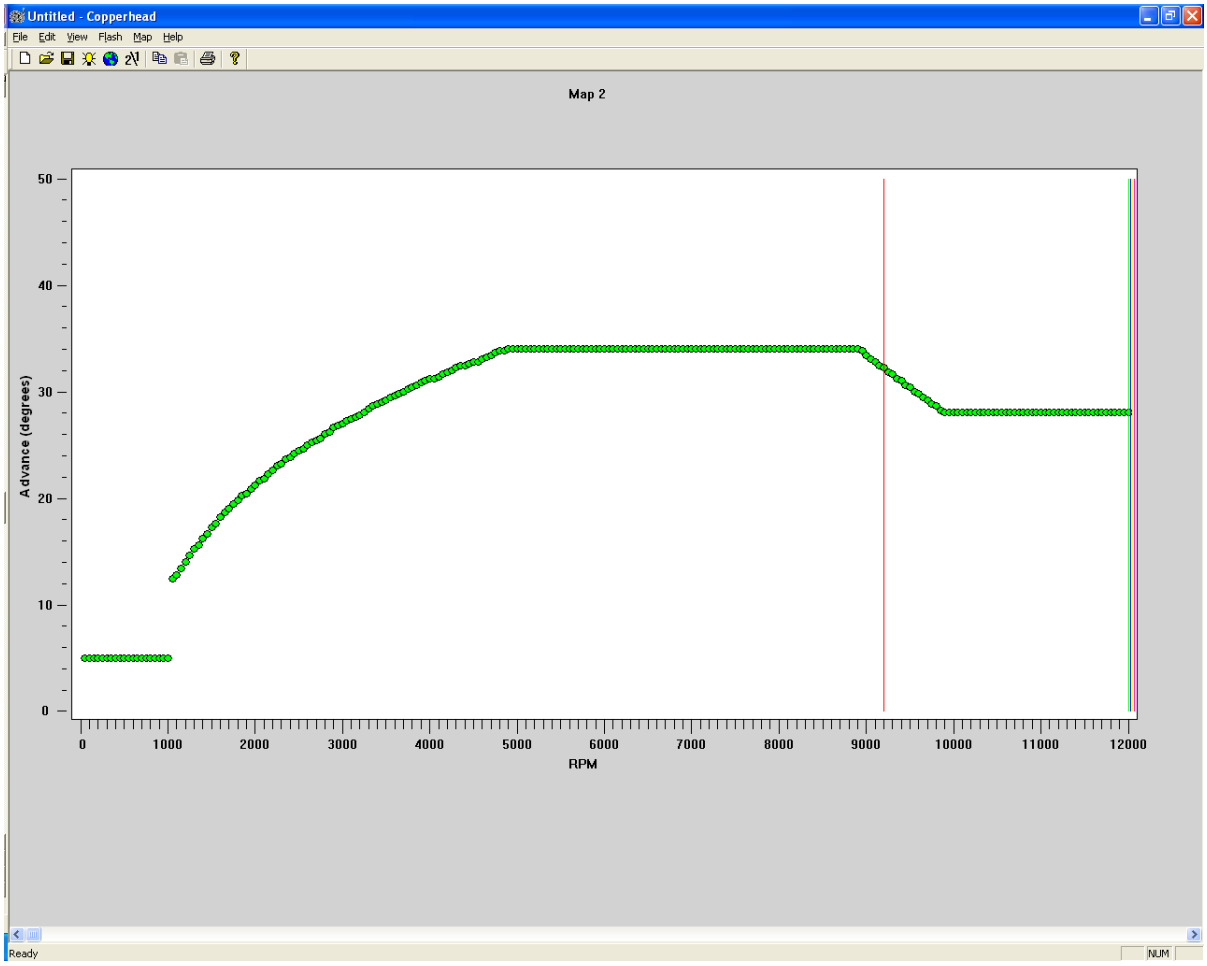
This example will show you how to create Map #1 optimized for 87-octane, and Map #2 optimized for 91+-octane fuel.

Start the application and click on MAP/LOAD DEFAULT. Press the "–" (minus) key to zoom out until all 12000 RPM is displayed.

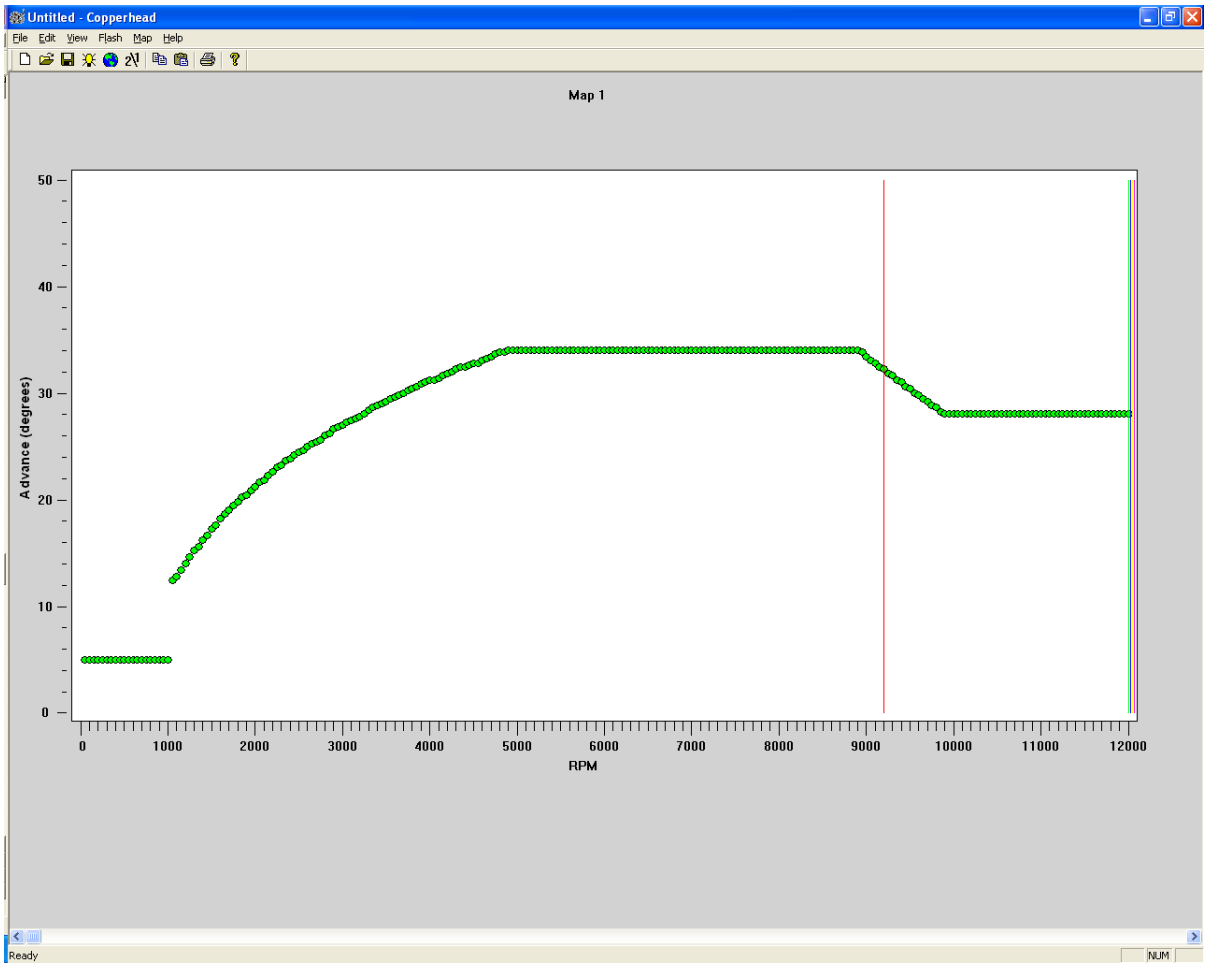
The red line shows the revolution limiter. The other programmable outputs default to 12000 RPM, and are slightly staggered to allow you to see all four.



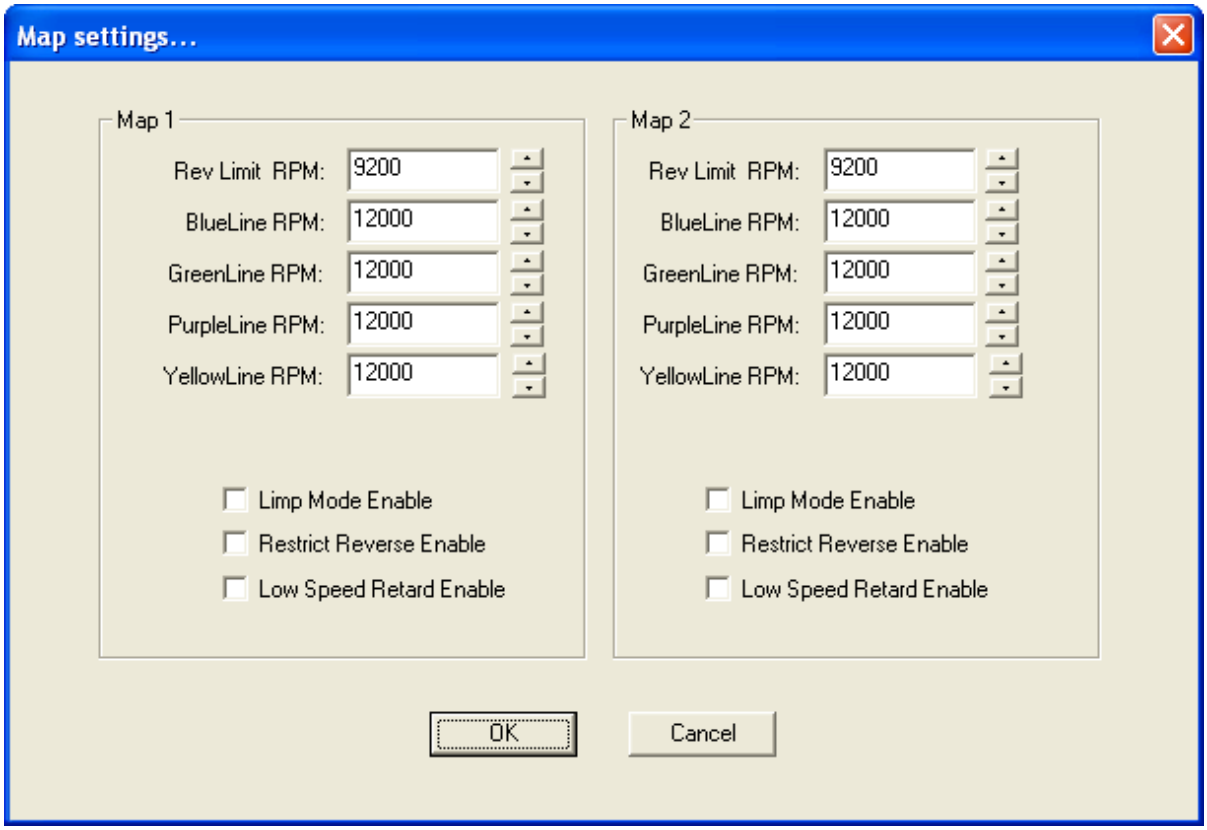
Click on the 2/1 button to bring up Map #2. Click on MAP/COPY MAP to copy the map to the clipboard.



Click on the 2/1 button to bring up Map #1. Click on MAP/PASTE MAP to overwrite Map #1 with Map #2. The revolution limiter and programmable outputs are copied as well.



Click on MAP/SET OPTIONS and adjust the revolution limiter, programmable outputs, or limiters if necessary.



Click on the 2/1 button to bring up Map #2. Click on the MAP/ADD OFFSET menu. Increment the offset to 3.0-degrees, and press "OK".

Feel free to save the map for later use by using the FILE/SAVE menu. You do not need to save the map to program the interface, but once the application is closed, it will be lost if not saved. You cannot read maps out of the USB Memory Interface or CDI. You can save the map for later, or so you can send it to other users.

Connect the USB Memory Interface to your computer, and click on the globe icon on the tool bar (MAP) to download the maps into the USB Memory Interface. When it is complete, press "OK", and unplug the pod.

See the "Uploading New Maps to the CDI" section for details on programming the map in to the CDI.

7 UPLOADING NEW MAPS TO THE CDI

The CDI will download new maps when the key is first turned on, and the USB Memory Interface is connected to the CDI.

Load the USB Memory Interface with your desired maps. Disconnect the interface from your computer.

Remove the cover from the DB9 interface port on the CDI. Ensure the key is turned off, and connect the USB memory interface directly to the CDI. This process does not require a computer to complete. Turn on the key (but do not start the engine).
NOTE: DAMAGE TO THE USB MEMORY INTERFACE AND/OR CDI MAY OCCUR IF THE ENGINE IS CRANKED DURING THIS DOWNLOAD PROCESS.

The status and belt light (if applicable) will remain off when the maps are being downloaded. Once the download is complete, the lights will come on solid to indicate completion. **Do not unplug or disturb the unit while it's programming.** This can take up to 10 seconds if the maps are vastly different from the onboard maps. If the changes are minor, the download will take less than a second.

Turn off the key, and unplug the interface. Replace the DB9 protective cover. The machine is now ready to use.

NOTE: Downloading new maps overwrites the maps that were currently in the CDI. There is no way to read out and save the CDI maps that were previously loaded. Multiple USB Memory Interface devices can be loaded with different maps, and easily downloaded with the above procedure.

8 UPGRADING YOUR CDI FIRMWARE

The Copperhead CDI has the ability to upgrade its firmware to support new features and updates.

In order to upgrade the CDI firmware, the USB interface must be connected to the computer and the CDI at the same time. The CDI requires power to be programmed, and must remain in the ATV. Using a laptop is the easiest method.

Before upgrading the firmware, the USB Memory Interface MUST be pre-loaded with a set of maps. The CDI will download the maps after the firmware upgrade.

Plug the USB Memory Interface into the computer via the USB cable, and directly into the CDI. Turn on the ignition, but do not start the engine.

NOTE:
THE KEY MUST BE OFF WHEN THE MEMORY POD IS CONNECTED OR DISCONNECTED. FAILURE TO DO SO MAY DAMAGE THE POD AND/OR CDI.

Click on the FLASH/WRITE FLASH menu (or the yellow flash bulb on the toolbar). Browse for the new firmware file (with the .VDI extension), and click “OPEN”. The original versions will be located on your CD in the "Firmware" folder. Latest versions can be downloaded off of our website: http://www.velocitydevices.com. Click on the "Support" tab. Find the version that is applicable to your CDI, and "right-click" and "Save Target As" to save it to disk. A dialog box will display the programming status. **Do not unplug or disturb the unit while it's programming.** If the download was successful, the CDI will turn on the status and belt light (if applicable). Once the unit has been successfully programmed, click “OK”, turn off the ignition, and unplug the USB Memory interface. It can take up to a minute to download new firmware into the CDI.

If the CDI failed to program correctly, ensure the USB interface is fully connected to the CDI and retry the process. If you still have problems, contact technical support.

NOTE:
THE CDI WILL NOT START THE ENGINE WITH THE MEMORY POD CONNECTED. DO NOT ATTEMPT TO START THE ENGINE WITH THE POD CONNECTED.